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**An Evaluation of the Effects of the Presence of Low-Preferred Items on
the Resurgence of Communicative Responses in Persons with
Developmental Disabilities**

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Developmental Disabilities**

by

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Dedication

This work is dedicated to all persons with disabilities and their families. Thank you for inspiring me with your challenges, giving me perspective on life, teaching me acceptance, and bringing me joy in your successes.

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This project was not completed without the support and encouragement of a number of key individuals. I would like to thank my dissertation committee members for their time and feedback. Specifically, I would like to thank my advisor, Dr. Terry Falcomata, for creating an academic environment conducive to collaboration and supportive of original thought, and for his patience in managing my strengths and lesser strengths. I would like to thank Ashley Bagwell for her role as my main assistant in carrying out sessions, coding data, and providing intellectual companionship throughout this project. Lastly, I would like to thank my family who have supported me in countless ways throughout my academic journey. A special note of thanks goes to my husband Robert for his support and love throughout this project.

ABSTRACT

An Evaluation of the Effects of the Presence of Low-Preferred Items on the Resurgence of Communicative Responses in Persons with Developmental Disabilities

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The University of Texas at Austin, 2017

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The purpose of the current study was to evaluate the effects of the presence of low-preferred items during phase 3 on the resurgence of a previously taught communication response in persons with developmental disabilities and communication delays. To set up the phase 3 experimental condition, two phases occurred prior to the third phase, consistent with the resurgence paradigm (Epstein, 1983): (1) the reinforcement of communication target response 1 and (2) extinction of target response 1 and reinforcement of alternative response 2. During the third phase, all responses were extinguished across conditions, and conditions alternated every 2 min between (a) a condition where two low-preferred items were available and (b) no items were available. Results were discussed in terms of treatment relapse literature and some of the challenges facing both basic and applied researchers.

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CHAPTER 1: INTRODUCTION

Resurgence is the recovery of a previously-reinforced, but extinguished response that re-emerges when reinforcement for a second trained response is withheld (Epstein, 1983). Even though the first response has not been reinforced, it often re-emerges under these conditions. This effect was demonstrated in pigeons (e.g., Epstein & Skinner, 1980; Lieving & Lattal, 2003), and in other animal studies, as well as in humans (e.g., Wilson & Hayes, 1996; Dixon & Hayes, 1998; Bruzek, Thompson, & Peters, 2009; Doughty, Kastner, & Bismark, 2011). Since being demonstrated as an effect, there have been further experiments manipulating variables within the model and documenting effects on resurgence. Some of these manipulations have focused on length of exposure to different conditions (e.g., Winterbaur, Lucke, & Bouton, 2013), and how schedules of reinforcement affect patterns of responses during conditions likely to produce resurgence (e.g., Reed & Morgan, 2007; Podlesnick & Shahan, 2009).

Investigations that seek to uncover the variables and conditions functionally related to resurgence are important to applied populations. Resurgence has been investigated as a relapse model in drug addiction (e.g., Podlesnik, Jimenez-Gomez, & Shahan, 2006), and in the treatment of challenging behaviors for persons with developmental disabilities (e.g., Lieving, Hagopian, Long, & O'Connor, 2004; Volkert, Lerman, Call, & Trosclair-Lasserre, 2009). Discovering how to manipulate variables to reduce the likelihood of clinical relapse is an important application of basic findings. For example, within the treatment of challenging behavior in persons with developmental disabilities, it would be beneficial to understand the relationship between environmental variables that contribute to the likelihood that challenging behaviors will re-emerge when appropriate communicative behaviors do not result in reinforcement. Conversely, for example, it would be important to understand how to strengthen the resurgence of appropriate

communicative responses so that these adaptive behaviors are the ones that become likely to persist during challenges to treatment.

Much of the current literature pertaining to persons with developmental disabilities and treatment relapse includes studies with the purpose of demonstrating the effect of resurgence within populations of persons with disabilities, showing the resurgence of challenging behavior (e.g., Lieving et al., 2004; Volkert et al., 2009) as well as appropriate communication responses (e.g. Hoffman & Falcomata, 2014). More complex manipulations of the resurgence model within the population of persons with developmental disabilities are beginning to emerge in the literature. Wacker et al. (2011) conducted intermittent extinction probes in which an appropriate alternative response was no longer reinforced to evaluate the persistence of challenging behavior over time for persons with developmental disabilities participating in long-term treatment using Functional Communication Training (FCT; Carr & Durand, 1985). In terms of results, there was variability across participants. Some participants showed rapid reductions, and low resurgence of challenging behavior during extinction sessions, while others showed resurgence of challenging behavior even after months of treatment. The general trend for most participants showed a reduction in resurgence of challenging behavior over time with FCT.

More recently, studies have examined the role of stimulus control in resurgence. Basic studies have shown that stimulus conditions associated with higher level of reinforcement, occasion higher levels of responding during tests for resurgence (Reed & Morgan, 2007; Podlesnik & Shahan, 2009). Wacker et al. (2013) was the first investigation focusing on an applied population to examine the role of stimulus control on resurgence in persons with disabilities. Their investigation evaluated whether the presence of a microswitch (a stimuli previously associated with reinforcement) during the test for resurgence would increase levels of

resurgence compared to conditions where there was no microswitch. Data did not show a functional relation. The dearth of applied research investigating stimulus control and resurgence, and mixed findings on the role of stimulus control in the basic literature (Doughty, da Silva & Lattal, 2007) indicate a need for this area of research. Further studies that manipulate variables within the 3-phase paradigm, and show effects on resurgence in applied populations will help to further the development of treatments that have lasting results.

Recent bi-directional works between basic and applied literature has amassed a growing number of studies that are helping to bridge gaps and “translate” basic works into more applied contexts, and vice-versa (e.g., Virues-Ortega, Hurtado-Parrado, Cox, & Pear, 2014). Environments that are used in basic experimental preparations focusing on animal behavior are less complex than human environments, and thus lend themselves well for isolating behavioral variables that are often difficult to isolate in the applied contexts. Although this is a strength of the basic paradigm, it is difficult to explore some of the more subtle variables at work within more complex systems. For example, within the basic literature, the types of reinforcers used are limited (usually sucrose, pellets, or drugs). Thus, it is difficult to explore how “preference” affects resurgence within basic behavioral experimental preparations. However, in studies with persons with developmental disabilities, it has been shown that the addition of preferred items to a context can change the outcomes of assessments such as functional analysis (e.g. Ringdahl, Winborn, Andelman, & Kitsukawa, 2002). Level of preference for available stimuli (i.e., high or low-preferred) can also affect the extent to which stimuli may interfere with behavior during assessment conditions (Roscoe, Carreau, MacDonald, & Pence, 2008).

Within the resurgence literature, all of the current applied studies have systematically observed the result of adding and removing high-preferred items within an austere context (i.e.,

no other items were available during the “test for resurgence”). When implementing communication training within clinical contexts, it is rare that high-preferred items are removed and withheld in a context void of alternative stimuli. It is more often the case, that when the high-preferred item is removed and unavailable (e.g., when an iPad needs to charge or the screen is broken) there will be other items (often less preferred) available to the individual. Thus, the current investigation seeks to evaluate the effects of the presence of low-preferred items during phase 3 on the resurgence of the first-learned response in children with developmental disabilities and communication delays.

CHAPTER 2: REVIEW OF THE LITERATURE

Functional Communication Training (FCT) is a treatment for persons with challenging behavior and communication deficits (Carr & Durand, 1985). It involves performing an assessment of the environmental contingencies maintaining the challenging behavior, and then substituting the challenging behavior with a functionally-equivalent appropriate request. During treatment, reinforcement is withheld for challenging behavior, and delivered following the appropriate response (also known as Differential Reinforcement of Alternative behavior or DRA). FCT is one of the most widely-studied interventions for the behavioral treatment of challenging behavior in persons with communication deficits (Tiger, Hanley, & Bruzek, 2008), and is a well-established intervention for the treatment of challenging behavior in children with intellectual disabilities (Kurtz, Boelter, Jarmolowicz, Chin, & Hagopian, 2011). Function-based assessment and the teaching of appropriate communication is legally required for persons who exhibit challenging behavior and who are receiving Special Education services in the U.S. public school system under the Individuals with Disabilities Education Act (IDEA) of 2004. The treatment is effective when delivered with high treatment fidelity, however when treatment challenges occur, challenging behavior often re-emerges (St. Peter Pipkin, Vollmer, & Sloman, 2010; Wacker et al., 2011). In developing FCT further, it is important to understand the mechanisms behind this relapse, and if there is anything we can do when teaching appropriate behavior and eliminating challenging behavior that will make the treatment more durable.

One model for understanding behavior that comes back after successful treatment is resurgence. Resurgence is the re-emergence of a previously-reinforced and subsequently extinguished response during extinction of a second response within the same response class. This is a model that requires three parts: (1) initial reinforcement of a target behavior; (2)

extinction of this response and reinforcement of a second alternative response, and (3) extinction of both responses (Epstein, 1983). If during the third phase, the initial target behavior recurs, this is an example of resurgence. Resurgence has been suggested as a model to explore treatment relapse in drug and alcohol addiction (e.g. Podlesnik, Jimenez-Gomez, & Shahan, 2006), and more recently in the treatment of challenging behavior in populations using FCT (i.e. DRA) when the treatment is no longer implemented with fidelity (Volkert et al., 2009). In terms of the treatment relapse model for persons with developmental disabilities, the first phase is analogous to the reinforcement of challenging behavior (which often occurs prior to treatment in this population). The second phase is analogous to the treatment of challenging behavior using FCT in which reinforcement is withheld following challenging behavior, and a functionally-equivalent appropriate response is reinforced. The third phase represents “treatment relapse” or what occurs when the appropriate response (for a variety of clinical reasons) no longer contacts reinforcement. If the original challenging behavior re-emerges during the third phase, this re-emergence is considered resurgence of challenging behavior.

In addition to treatment relapse of challenging behavior in persons with developmental disabilities, which is usually considered an undesirable outcome, resurgence can also be viewed as a model of persistence of appropriate responding. The process of shaping appropriate forms of communication fit the resurgence paradigm. Shaping and differential reinforcement have been used for decades as a successful method to teach communicative responses for many persons with disabilities who exhibit communication delays (e.g. Isaacs, Thomas, & Goldiamond, 1960; Baer, Peterson, & Sherman, 1967; Bourett, Vollmer, & Rapp, 2004). When a practitioner is attempting to shape more sophisticated forms of communication (such as vocal manding), he or she may place other forms of communication on extinction (such as pointing at the item), and

reinforce only the more sophisticated form. In instances when the sophisticated form no longer results in reinforcement, the previous form of communication may re-emerge, despite the fact that it has no recent reinforcement history (e.g. Hoffman & Falcomata, 2014). This is another applied example of resurgence within the population of persons with developmental disabilities.

Resurgence, and the underlying variables that contribute to resurgence, are an important avenue for study, especially considering the widespread use of DRA as a treatment for challenging behavior. If we can understand the mechanisms behind resurgence, then perhaps we can manipulate those variables to decrease the likelihood of unwanted behaviors re-emerging, while simultaneously increasing the likelihood that more appropriate forms of communication might occur during challenges to treatment.

Studies that look at the variables contributing to resurgence can be divided into categories based on where the manipulated variable is within the model (i.e. phase 1, phase 2, and phase 3). Since the current investigation manipulated environmental aspects of phase 3, a review of studies that included manipulation of variables in phase 3 of the resurgence model was conducted.

Method

The following databases were used in the automated search using the search terms “resurgence” and “reinforcement OR reinforcer” in the abstract of the article: Academic Search Complete, Psychology and Behavioral Sciences Collection, Educational Resources Information Clearing House (ERIC), and PsychINFO. After identifying qualified studies, a hand-search of the reference section of each article was conducted.

Inclusion Criteria. Articles had to pertain to behavioral resurgence as defined by Epstein (1983). Included articles had to contain at least one experiment that manipulated variables within

phase 3 of the resurgence paradigm. For the purposes of this analysis, phase 1 included reinforcement of response 1. Phase 2 of the resurgence paradigm included elimination of response 1 and reinforcement of response 2. Phase 3 included elimination of response 2, or systematic changes or disruption of response 2 that were meant to “test for resurgence”. All articles were from peer-reviewed journals and available in English.

Exclusion Criteria. Duplicate articles returned by the search were excluded. Reviews and theoretical articles within resurgence literature were also excluded.

Articles were analyzed and the following relevant information was gathered, and summarized in *Table 1* and *Table 2* (See Appendix) for each experiment: type of inquiry (i.e. applied, basic or translational), experimental question and participants included in the investigation, independent and dependent measures, and a brief summary of results.

Each experiment was categorized as basic, translational, or applied based on the following definition. An experiment was considered basic if non-human animals were the subject of investigation. A translational experiment was defined as one studying humans, but having a dependent measure that was not socially-relevant. An experiment was categorized as applied if it involved human participants and measured socially significant behaviors.

Results

The original search yielded 64 articles. When duplicate articles were excluded, 59 articles remained. The 59 titles and abstracts were read and nine were excluded for irrelevance to behavioral resurgence (e.g. use of resurgence in the abstract as a colloquial term for renewed interest in a subject; referring to some related behavioral phenomenon such as renewal or reinstatement). Of the 50 remaining articles pertaining to resurgence, 10 were excluded as

reviews of the literature or as theoretical in nature. The remaining 40 articles were examined and coded to identify the phase, if any, that variables were manipulated during the investigation. Of the 40 articles, nine included at least one investigation that manipulated variables in phase 3. A hand search of the reference section of the nine articles did not yield any additional studies. Of the nine articles, two of them had two experiments that were included that met the criteria. Results reflected the 11 investigations.

Overview of Types of Studies, Participants and Dependent Measures. Of the results, four were considered applied, one was translational, and six were basic. Within the four applied studies, all of them included participants with developmental disabilities and communication delays, and measured challenging behavior and appropriate requests (See Appendix, Table 2). One study also measured task completion (Wacker et al., 2013). The translational experiment used undergraduate students as participants and measured mouse clicks on a computer screen (Marsteller & St. Peter, 2012). Of the six basic studies, four studied pigeons, using either key pecks and/or treadle presses as responses. The two remaining basic studies used rats as subjects, and measured lever presses and nose pokes.

Experimental Questions

Manipulating Rates of Reinforcement during Phase 3. Of the 11 studies, seven examined manipulations of schedules of reinforcement in phase 3 (See Appendix, Table 1). One study looked at both stimulus and reinforcer control mechanisms of resurgence (Podlesnik & Kelley, 2014). Of the six remaining studies that examined rates of reinforcement, two of the studies investigated the effects of implementing a Fixed Time (FT) schedule on resurgence (Leiving & Lattal, 2003, Exp. 3; Marsteller & St. Peter, 2012). Two other studies (Leiving & Lattal, 2003, Exp. 4; Volkert et al., 2013, Exp. 2) investigated the effect of implementing very lean,

“extinction-like” schedules of reinforcement on resurgence. Similarly, Jarmolowicz & Lattal (2014) looked at the impact of progressively thinner schedules of reinforcement for the alternative response, on resurgence of the target response in pigeons. Finally, two experiments in a combined translational/applied investigation evaluated whether reducing the rate of reinforcement of the alternative response following phase 2 affected resurgence in phase 3 (Marsteller & St. Peter, 2012).

Stimulus-Context Manipulations during Phase 3. Of the 11 studies, two investigated stimulus-context variables and their impact on resurgence. One applied study examined the effect of the presence of an object previously associated with reinforcement (an unprogrammed microswitch) on resurgence of challenging behavior (Wacker et al., 2013). One basic study looked at rates of resurgence under conditions previously associated with reinforcement compared to control conditions (Podlesnik & Kelley, 2014).

Bio-Medical Interventions prior to Phase 3. Finally, two basic studies investigated the effects of bio-chemical intervention on behavioral resurgence. Specifically, the two studies explored the impact of injections of dopamine and adrenergic agonists on rates of resurgence (as well as alternative responses) during phase 3 (Pyszczyński & Shahan, 2014; Quick, Pyszczyński, Colston, & Shahan, 2011).

There was one study that examined whether the mechanism of resurgence was one controlled by adding and removing reinforcement or by adding and removing stimuli associated with previous reinforcement (Podlesnik & Kelley, 2014). This basic arrangement was the only study that looked at both reinforcer control and stimulus control mechanisms within the same investigation.

Study Results

Results will be divided into three broad categories which include: Studies that manipulated reinforcement during phase 3, studies that manipulated the stimulus context during phase 3, and studies that included some bio-chemical intervention prior to the initiation of phase 3.

Manipulations of Rates of Reinforcement in Phase 3. In terms of results, studies showed that implementing Fixed Time (FT) schedules following phase 2 (at similar amounts of reinforcement as in phase 2) did not result in resurgence of the first response (Lieving & Lattal, 2003, Exp. 3). This basic study was translated to a population of persons with developmental disabilities who had histories of challenging behavior by Marsteller & St. Peter (2014). In an applied population, FT schedules following DRA treatment (at similar rates of reinforcement as during treatment) mitigated against resurgence of challenging behavior. Rates of appropriate requesting were shown to be more variable during the FT condition relative to the DRA condition. When relatively lean “extinction-like” schedules for appropriate responding were implemented, resurgence of challenging behavior was observed reliably (Volkert et al., 2009, Exp. 2). In the analogous basic study by Lieving & Lattal (2003, Exp. 4), a lower magnitude of resurgence was observed during the lean-schedule conditions compared to resurgence under extinction conditions. Along this line of research, Jarmolowicz & Lattal (2014) found that implementing progressively leaner schedules of reinforcement for an alternative response resulted in resurgence for 3 out of 4 pigeons. Reducing rates of reinforcement to 70% that of previous reinforcement following DRA produced resurgence of the original mouse clicking response in undergraduate students, though at much lower rates as compared to the extinction condition, where no reinforcement was available (Marsteller & St. Peter, 2012, Exp. 1). This experiment was followed up with a similar clinical investigation in one participant with autism

and challenging behavior, where mands were subsequently reinforced at 70% of the rate at which they were reinforced in the phase 2 condition. Resurgence of challenging behavior was observed during the lean reinforcement condition, but much greater resurgence of challenging behavior was observed during the first exposure to extinction (Marsteller & St. Peter, 2012, Exp. 2).

Manipulations of Stimulus Context and Resurgence. In general, basic studies of stimulus control showed that when stimuli previously associated with reinforcement were present during phase 3, resurgence was greater, although the effect did not appear to be as robust as the effects of manipulating reinforcement on resurgence (Podlesnik & Kelley, 2014). The only applied study (i.e., Wacker et al., 2013) that sought to replicate the basic findings in children with disabilities and challenging behavior, did not find a difference between the conditions where stimuli previously associated with reinforcement were available as compared to a condition where there were no associated stimuli present.

Results of Bio-medical Interventions in Animals. The third category of phase 3 manipulations of the resurgence paradigm includes investigations of the effects of bio-medical interventions on resurgence. Specifically, one study examined the effect of injecting rats with a dopamine agonist prior to the test for resurgence (Quick et al., 2011). The second study expanded on the first and compared resurgence of rats injected with dopamine agonists and adrenergic agonists compared to controls (Pyszczyński & Shahan, 2014). In both studies, an injection of dopamine agonists prior to the initiation of phase 3 reduced resurgence, and also reduced responding on the alternative response. In rats injected with adrenergic agonists prior to phase 3, resurgence of response 1 was reduced, while the alternative response was less affected, relative to rats injected with dopamine agonists.

Discussion

Summary

The above investigations provided evidence that manipulating reinforcement within phase 3 can affect levels of resurgence of the target behavior, and that the closer those rates of reinforcement were to the phase 2 rates, the less “resurgence” was observed (i.e. Lieving & Lattal, 2003, Exp. 3; Marsteller & St. Peter, 2012). Conversely, the leaner or more “extinction-like” the schedules approximated, the greater the resurgence (Lieving & Lattal, 2003, Exp. 4; Volkert et al., 2009). Though less robust than the findings regarding manipulations of reinforcement, the basic investigations showed that, in addition to reinforcement, when stimuli previously associated with reinforcement were present during phase 3, more resurgence occurred (Podlesnik & Kelley, 2014). These findings were not clearly replicated within the applied research (Wacker et al., 2013). Finally, a few studies showed that certain injections prior to phase 3 reduced resurgence in rats (Quick et al., 2011; Pyszczynski & Shahan, 2014)

Implications for Practice

Currently, the research is limited in terms of recommendations for practice to implement in the immediate environment (phase 3) to reduce treatment relapse in persons with developmental disabilities. One study suggested that providing access to the reinforcer on a schedule similar to that used during the DRA procedure will keep challenging behavior low (Marsteller & St. Peter, 2014). The difficulty here is that providing reinforcement on dense, nearly-continuous (i.e., FT 1 s and FT 2 s) is not practical. Marsteller and St. Peter (2012) was the only study with clinically-relevant population that offered recommendations for treatment during resurgence conditions.

Implications for Research

An inverse relationship exists between the number of current “Implications for Practice” and the “Implications for Future Research.” The implications will be discussed as they pertain to research in the basic, translational, and applied areas.

Basic Research. Basic researchers should continue to explore basic mechanisms of resurgence in phase 3, expanding on previous research which examined the role of reinforcement and stimulus control mechanisms during this phase. In addition, basic researchers should pay close attention to studies that “fail to translate” basic findings (i.e. Wacker et al., 2013; Podlesnik & Kelley, 2014) into application. Investigating these questions will lead to deeper understanding of the mechanism (or more likely, complex combinations of mechanisms) responsible for the discrepancy in outcomes. Lastly, basic researchers should continue to create more complex scenarios that might help to explain complex applied scenarios. For instance, one aspect of applied research that does not translate very well to basic research, is the manipulation of using high-preferred vs. low-preferred items as reinforcers, as pigeons and rats have a relatively limited number of reinforcers relative to humans. The reviewed research showed that if FT schedules were implemented following DRA, little resurgence was observed (e.g. Lieving & Lattal, 2003). Additional studies are needed to evaluate the effects on resurgence if a non-equivalent reinforcer were delivered on a FT schedule during phase 3. Further studies could investigate whether reinforcers of lower quality or amount would maintain low levels of resurgence if delivered on FT schedules during phase 3.

Translational Research. Among the reviewed studies, Marsteller & St. Peter (2012) was the only paper that included a translational investigation (as defined by this review), along with a follow-up applied investigation. More works that integrate replications within humans in non-clinical, controlled environments are needed to translate basic findings. For example, Podlesnik

& Kelley (2014), using a complicated design, isolated and compared the effects of stimulus control verses reinforcer control on resurgence in pigeons. Due to the study's complexity and number of controls, it would not easily translate to an applied population, though it would be important to attempt replication within humans, perhaps in a more controlled, non-applied context. Translational work provides a middle ground to investigate variables with more control than in clinical populations, but within humans which pushes the line of resurgence research closer to meaningful outcomes.

Applied Research. The reviewed studies reflected recent progress in applied research to demonstrate outcomes generated in basic studies in clinically-significant populations in relevant dependent measures (e.g. challenging behavior, mands). Work that continues to move basic research down the pipeline to clinical populations is needed. Within the realm of treatment of challenging behavior in persons with disabilities, simple extinction-probes have been used to assess progress in terms of likelihood of relapse over time when using FCT (Wacker et al., 2011). Perhaps this assessment technology could be refined by using progressive delay schedules (i.e., VI 30 s FT x s; Jarmolowicz & Lattal, 2014) to assess at which schedule of reinforcement magnitude the challenging behavior recurs. If the delay to challenging behavior is increasing over time, this could be a measurement of treatment progress as well as give practitioners an idea of the “level of reinforcement” necessary to maintain appropriate behavior.

In addition, it is strongly recommended that applied researchers read basic research and create interventions (combining what is known) that are in line with what basic researchers have uncovered. The basic studies in phase 3 manipulations of the resurgence paradigm show two mechanisms of action that contribute to resurgence – stimulus control and reinforcement (or lack thereof). Although isolating variables in applied settings allows for further more precise

technologies to be developed, combining what basic researchers have isolated to create an intervention “package” to reduce resurgence is what will, in essence, contribute to the most impactful socially significant outcomes. While continuing to translate studies to relevant populations, we also need to explore combinations of treatments that are consistent with the mechanisms of action demonstrated in basic paradigms. No studies described in the above review fit this description.

Collaboration between basic and applied researchers. Of all of the reviewed studies, only one study (Podlesnik & Kelley, 2014) represented teamwork between a traditionally-basic and a traditionally-applied researcher. Though there has been a focus on promoting translational research in behavior analysis in recent years (Virues-Ortega et al., 2014), the actual collaboration among authors with backgrounds in both applied and basic research within the reviewed studies was limited. Bi-directional investigations among researchers with different areas of expertise is essential in helping to translate basic findings to therapeutic application to improve treatment outcomes. Conversely, many times the applied world generates questions that would be better answered in a more controlled, lab environment, and so collaborations can facilitate applied clarification questions reaching basic researchers. Furthermore, in collaborating, the field of behavior analysis can more closely align our terminology, and more appropriately discuss implications for practice, so that journal articles that were previously inaccessible (to either applied or basic researchers) can be more readily consumed. One example of this slight terminology alignment is that instead of referring to the responses generically as “Response 1” and “Response 2,” Podlesnik & Kelley (2014) refer to them as “the target response” and “alternative response” which is more closely in line with the paradigm of treatment relapse, and thus more readily accessible to applied researchers reading this article. In addition, while the

experiment itself is basic, the concepts are relayed in the introduction and the discussion, citing relevant applied studies in resurgence (e.g. Volkert et al., 2009; Wacker et al., 2013).

Another reason for collaboration between basic and applied researchers is that when basic experiments are translated to applied examples, they do not always yield the same results (e.g. Podlesnik & Kelley, 2014; Wacker et al., 2013). Though we may only speculate as to why results were not consistent, having a basic researcher involved in designing and implementing an applied investigation might shed light on some of the discrepancies between the basic model and the applied situation that might help to further future investigations to explain the differences.

Reviewed Studies and Rationale for Current Investigation. The current investigation examined the effect of low-preferred items during the “test for resurgence” in persons with disabilities and communication delays. Some basic studies (beyond the scope of the current review) had suggested that high rates of reinforcement (as is often the case during DRA) can lead to high levels of resurgence of challenging behavior when the appropriate behavior is no longer being reinforced (e.g. Nevin, Tota, Torquato, & Shull, 1990; Thrailkill & Shahan, 2012). While the above reviewed studies demonstrated that upon denying or even delaying reinforcement for appropriate responding, children with disabilities often reverted to challenging behavior (Volkert et al., 2009; Wacker et al, 2013), these studies were conducted in environments void of other reinforcers. In applied situations, rarely do requests for an item occur in a vacuum where other forms of reinforcement are not available. For instance, if a child requests an iPad, but the iPad is out of batteries and needs to charge, the caregiver or therapist would likely try to redirect the child to another toy (perhaps less preferred than the one being denied). In this situation, the rate of reinforcement need not be lowered to prevent challenging behavior, but the child must re-direct to another reinforcer. In line with this example, this study sought to investigate whether

having access to low-preferred items during the test for resurgence had an impact on the level of resurgence in persons with developmental disabilities and communication delays.

While the current investigation was not a direct replication of a basic experiment, it was grounded in the results of the basic inquiries on phase 3 manipulations in the resurgence paradigm. This investigation evaluated the effects of combined stimulus control and reinforcer control mechanisms on resurgence, as suggested above in recommendations for applied researchers. The available low-preferred items could serve as noncontingent reinforcement. Similar to the studies that showed that FT schedules reduced resurgence (Lieving & Lattal, 2003, Exp. 3; Marsteller & St. Peter, 2014) having lower-preferred items continuously available may also reduce resurgence. The low-preferred items may also acquire stimulus control over the behavior, in that they represent a new context (i.e., different from the one associated with past reinforcement). In other words, the low-preferred items may acquire discriminative properties that represent the non-availability of high-preferred tangibles. In this way, the items may become an S-delta for high-preferred reinforcement, and thus, the behavior that resulted in reinforcement previously, would be less likely to occur. As there are no previous studies (including basic studies) that provide a direct outline for translation, the current dependent measures were selected as mands, in lieu of challenging behavior. If results show differentiation, then further investigations can examine if the effects generalize to other topographies within the same functional response class (i.e. challenging behavior).

CHAPTER 3: METHOD

This chapter will explain this investigation's methodology, and be divided into four sections. The first section will include participant characteristics, a description of the locations of the experiment, and a list of materials used during the project. Second, pre-experimental assessments will be described. Third, dependent measures and data collection procedures will be explained, including interobserver agreement (IOA) calculations and methods for treatment fidelity evaluation. Fourth, the independent variable and experimental procedures will be described.

Participants

Four persons with developmental disabilities and communication delays participated in this study. A table was created to show participants' age, diagnosis (as reported by parent), current communication modalities, and challenging behavior observed. To be included in the study, all participants had a diagnosis of developmental disability by physicians or school personnel. Only students with a developmental disability diagnosis and a communication delay were included in the current investigation. All participants had limited or absent vocal repertoires, as confirmed through direct observation.

Setting

All procedures were conducted in the home setting. Before the experiment, participants were observed in the natural environment at home by the first author. Within the home, all sessions were implemented in a room which was chosen based on parent preference and with the object of choosing a space free from usual household distractions. Only the persons involved in research were present during study sessions.

Materials

Materials used included a table and chairs, two bigMack communicator switches (or in the case of one participant, raised boxes with communication cards) in different colors, as well as high-preferred items and low-preferred items (identified via formal preference assessment for each participant). All sessions were recorded using a video camera. Data was collected using paper and pencil for all pre-experimental conditions. Data collection software and computers were used to score the videos for phase 1, phase 2, and phase 3. To follow the time-based protocols, a digital timer was used.

Dependent Measures

Dependent measures included rate of communication response on each of the two bigMack switches, differentiated by color. For one participant, card touch (on raised boxes) was recorded. A communication response was defined as force applied to the bigMack switch with the hand such that the button made an audible click. Card touch was defined as the participant touching her hand to the card on the box. After a response, a new response was counted only if the participant fully removed her hand from the box, or moved her hand to touch the opposite box.

Measurement

Data Collection

All experimental sessions were visually recorded and subsequently scored by trained graduate students. The training consisted of the graduate student being given a list of operational definitions and video examples of each behavior. Following this, the graduate student used a computer-based data scoring program to score each occurrence of the target behavior. Each

session was broken down into 10-s intervals, and agreement between the trainee's score and the primary author's score were calculated. The training process continued until 90% exact agreement was reached or exceeded.

Interobserver agreement

The first author scored data for all sessions. A second independent data collector scored at least one-third of sessions selected randomly and balanced between participants and across the experimental conditions. After both observers coded the session, the session was broken down into 10-s intervals and compared for agreement. Agreement was calculated for each 10-s interval using the following formula:

$$\frac{A \text{ (frequency)}}{A \text{ (frequency)} + D \text{ (frequency)}} \times 100$$

Subsequently, the percentage agreement derived from each interval was averaged across the total number of 10-s intervals compared within each session, for an average session agreement. The mean IOA across all experimental sessions was calculated and reported in a table, along with the range of scores from lowest to highest for each dependent variable scored for each participant.

Treatment Fidelity

Treatment fidelity data was scored for all phase 3 sessions across all participants. The fidelity measures included whether or not low-preferred items were available during each session, and whether communication materials (two cards or two microswitches) were available to the participant. Data was reported in a table for each variable scored.

Independent Variable

The current investigation followed a three-phase resurgence model (Epstein, 1983). The independent variable consisted of access to lower-preferred (LP) items during the test for resurgence (phase 3), which was compared to a control condition where no access to low-preferred items was given. Phase 1 and phase 2 were pre-requisite conditions that set the occasion for the test for resurgence in phase 3. During phase 1, the first communication response (which will be referred to as the target response) was reinforced on a Fixed Ratio 1 (FR 1) schedule. In phase 2 reinforcement for the target response was withheld, and reinforcement was granted contingent on the occurrence of the second communication response (which will be referred to as the alternative response) following a FR 1 schedule. Phase 3 followed a multi-element design, and consisted of alternating between two conditions. During both of the conditions, the two highest-preferred items used to reinforce communication responses during phase 1 and phase 2 were visually present, but withheld contingent on a communication response (i.e. both the target communication and alternative communication responses were on extinction). In the enriched environment condition, the participant was given access to two low-preferred items (as determined by a previous preference assessment), and in the other condition, no preferred items were accessible.

Procedures

Preference Assessment

A list of preferred items was gathered from parents or teachers, and a paired-choice preference assessment was conducted for each participant (Fisher et al., 1992). For one participant, a Multiple Stimulus Without Replacement (MSWO; DeLeon & Iwata, 1996) assessment was used (due to a position bias when the paired-choice preference assessment was conducted). The two highest-preferred items were used as reinforcement for appropriate

communication responses in phase 1 and phase 2. The two lowest-preferred items (but items that were selected at least one time during the preference assessment) were used in phase 3 as part of the enriched environment condition.

Initial Mand Training

Mand training occurred for both the target and alternative responses before beginning the study sessions to establish the responses within each participant's repertoire. During the training sessions, the participant was seated at a table, directly across from the communication partner. Either the red or blue microswitch (or a raised card for one participant) was available on the table. Mand training was conducted using a four-step prompting procedure (i.e., no prompt, vocal, gestural, and physical guidance) until independent responding was observed at or above 80% of trials for consecutive sessions for both communication responses. Each session consisted of 5 trials. Contingent on microswitch press or card touch, the high-preferred items were delivered for 30 s. A response was considered independent if it occurred within 10 s of removal of the preferred item. Once the child showed mastery of the communication responses, phase 1 began.

Phase 1

During this phase, only the target communication response was available. Contingent upon a microswitch press or card touch, the participant was given the two highest-preferred items for 30 s. When the items were removed, if the child engaged in the target response, the items were returned for 30 s. This continued until there was at least 5 min of consistent responding. Consistent responding was defined as the target communication response occurring

independently within 10 s of the removal of the high-preferred items, and not within the 30 s high-preferred reinforcement interval.

Phase 2

During phase 2, the target response was available along with the alternative communication response. Responses to the target response did not result in reinforcement. Responses to the alternative response resulted in 30 s access to the two high-preferred items used during phase 1. The communication materials were rotated randomly to rule out a position bias as a contributing factor in the discrimination training of the two communication responses. This condition continued until there was at least 5 min of consistent responding (as defined in phase 1) on the alternative communication response, and no responding on the target response.

Phase 3: Experimental Condition

Phase 3 served as the test for resurgence. Two conditions alternated rapidly every 2 min in a multielement design. The initial condition sequence was counterbalanced across participants. Following each condition, there was a 30 s inter-trial-interval (ITI) where communication responses were removed from the table to prevent communication responses being directly followed with a change in condition (i.e., adventitious reinforcement). Across both conditions, the position of the target and alternative responses were rotated randomly and counterbalanced to control for a position bias.

Enriched Environment Condition. During this condition, the participant was given access to two low-preferred items (determined as low-preferred during the pre-experimental preference assessment). The high-preferred items were visible (though not accessible) to the participant. Both target and alternative communication responses were available on the table, but

communication responses did not result in any change to the environment. Target and alternative communication responses were recorded.

Non-enriched Condition. During this condition, the participant was not given access to any preferred items, though the high-preferred items still remained visible. The target and alternative communication responses remained on the table, and all communication responses were recorded.

Phase 3 was implemented until one of the following occurred: (a) communication responses extinguished (zero responses across both conditions), (b) clear differentiation between conditions occurred by visual inspection, or (c) undifferentiated data persisted. A threshold criteria of 15 minutes was set to terminate a session if high rates of challenging behavior occurred, however this was not reached by any of the four participants.

CHAPTER 4: RESULTS

This chapter will present the results of the study including (1) results of inter-observer agreement calculations; (2) results of treatment fidelity calculations; (3) summary of participants and participant characteristics; (4) preference assessment results for each participant; (5) results for pre-conditions Phase 1 and Phase 2 of the resurgence paradigms; and (6) the final experiment depicting results of Phase 3 of the resurgence paradigm across two conditions: low-preferred items available versus no low-preferred items available.

Measurement

IOA for Experimental Conditions

The mean IOA for each dependent variable as calculated for each participant is represented in *Table 3*. The averages for each measure ranged from 95-100% across all dependent measures. The ranges of agreement across sessions for each specific behavior were also reported. Across all experimental sessions, the range of agreement was 90-100%.

Table 3. Interobserver Agreement: Experimental Phase 3

Participant	Dependent Variable	Mean of All Sessions (%)	Range Across Sessions (%)
Kris	MS Press Target	99	96-100
	MS Press Alternative	98	90-100
	LP Item Engagement	95	94-96
Lily	Card Touch Target	98	92-100
	Card Touch Alternative	100	100
	LP Item Engagement	99	99
Mark	MS Press Target	97	92-100
	MS Press Alternative	96	90-100
	LP Item Engagement	97	97
Tommy	MS Press Target	98	91-100
	MS Press Alternative	95	90-100
	LP Item Engagement	100	99-100

Notes. See Method Section: IOA for how agreement was calculated.

Treatment Fidelity of the Independent Variable

During phase 3, treatment fidelity was, on average, above 99% for all participants for both fidelity in implementing access or no access to LP items (depending on the condition), as well as making both communication items (either cards or microswitch) available across conditions. The reported range across sessions was above 92% for all participants. Treatment fidelity for each participant and ranges across sessions are reported in *Table 4*.

Table 4. Treatment Fidelity: Experimental Phase 3

Participant	Fidelity Checklist	Mean of All Sessions (%)	Range Across Sessions (%)
Kris	Access or No Access to LP Items	99	92-100
	Both MS Available	100	93-100
Lily	Access or No Access to LP Items	100	100
	Both Cards Available	100	100
Mark	Access or No Access to LP Items	100	100
	Both MS Available	99	89-100
Tommy	Access or No Access to LP Items	100	100
	Both MS Available	99	92-100

Notes. Calculated by 10-s Whole Interval recording.

Participants

Table 5 displays participant characteristics including pseudonym, gender, age at time of study, diagnosis (as reported by parents), communication modalities, and forms of challenging behavior for each participant. Participants included three males and one female, aged 7-11 with a diagnosis of a developmental disability, as reported by parents. All participants had limited expressive vocal speech and communicated using a variety of modalities. Challenging behavior directly observed during the study or as reported by parents was included.

Table 5. Participant Characteristics

Participant	Gender	Age	Diagnosis	Communication Modalities	Challenging Behavior ²
Kris	Male	11	Autism	Typing one or two-word phrases; Vocal Approximations ¹	Scratching, Grabbing, Loud vocalizations, Hand-mouthing, Head-banging, Flopping
Lily	Female	8	Autism, Epilepsy	Pulling caregiver's hand to desired item, Tapping caregiver with hand	Elopement, Hiding preferred items
Mark	Male	7	2q32 Microdeletion, Atypical Autism, Ehlers-Danlos Syndrome	Sign; Sign Approximations; Voice-Output Device	Non-Compliance, Flopping, Throwing items, Property Destruction
Tommy	Male	9	Autism	Vocal Approximations ¹	Self-hitting, Whining, Crying, Flopping

Notes. ¹ understood by routine caregivers, but not generally intelligible; ² as directly observed or reported by parent

Pre-Experimental Assessments and Conditions

Preference Assessments

Preference Assessment Results for Lily. Lily chose movie and books 12 times during 14 presentations (86% of trials). These two items were used as her high-preferred (HP) items during the study. Dolls were chosen twice (14%) and light toys once (7%) out of 14 presentations, and were used as the low-preferred (LP) items during the study.

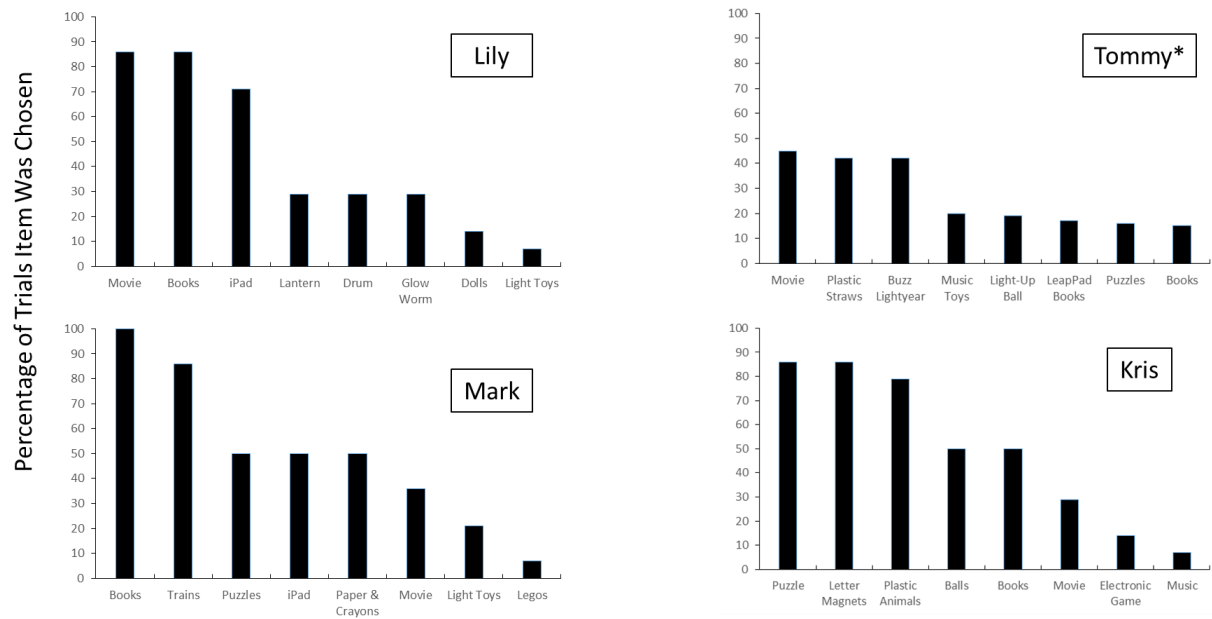
Preference Assessment Results for Mark. Mark chose books every time books was presented (100%) and trains 12 times during 14 presentations (86% of trials). Thus, books and trains were used as HP items during the study. Light toys was chosen three times (21%) and Legos once (7%) out of 14 presentations, and were used as the LP items during the study.

Preference Assessment Results for Tommy. Initially, a paired choice preference assessment was conducted with Tommy, but he showed a position bias (only choosing items presented on the left or when items were stacked, only choosing items on top). Following these results, his mother also noted that he showed a preference for choosing the top left answers

during a previous academic assessment. This position bias led to inconclusive preferences (all items were chosen 50% of the time), and so a MSWO was conducted with the items presented in a semi-circle fashion and the items rotated and counterbalanced to control for any position bias. The MSWO was repeated five times and yielded differentiated results, showing reliable preferences. A movie was chosen five times out of 11 presentations (45% of trials). Both plastic straws and a Buzz Lightyear figurine were chosen five out of 12 presentations (42% of trials). For the study, plastic straws were selected as the second-highest preferred item because they were selected first three times (when all eight items were present) compared to zero first selections for the Buzz Lightyear figurine. In summary, the movie and plastic straws were used as the HP items in the study. Puzzles were selected five times out of 31 trials (16%), and books were chosen five times out of 34 trials (15%). These were the two LP items used in the study.

Preference Assessment Results for Kris. Kris chose a puzzle and letter magnets 12 times during 14 presentations (86% of trials). These two items were used as his HP items during the study. An electronic game was chosen twice (14%) and music once (7%) out of 14 presentations, and were used as the LP items during the study.

Figure 1. Results of Preference Assessments



Notes. *Tommy's results are from a Multiple Stimulus Without Replacement. All other participants show results from a Paired Choice Preference Assessment.

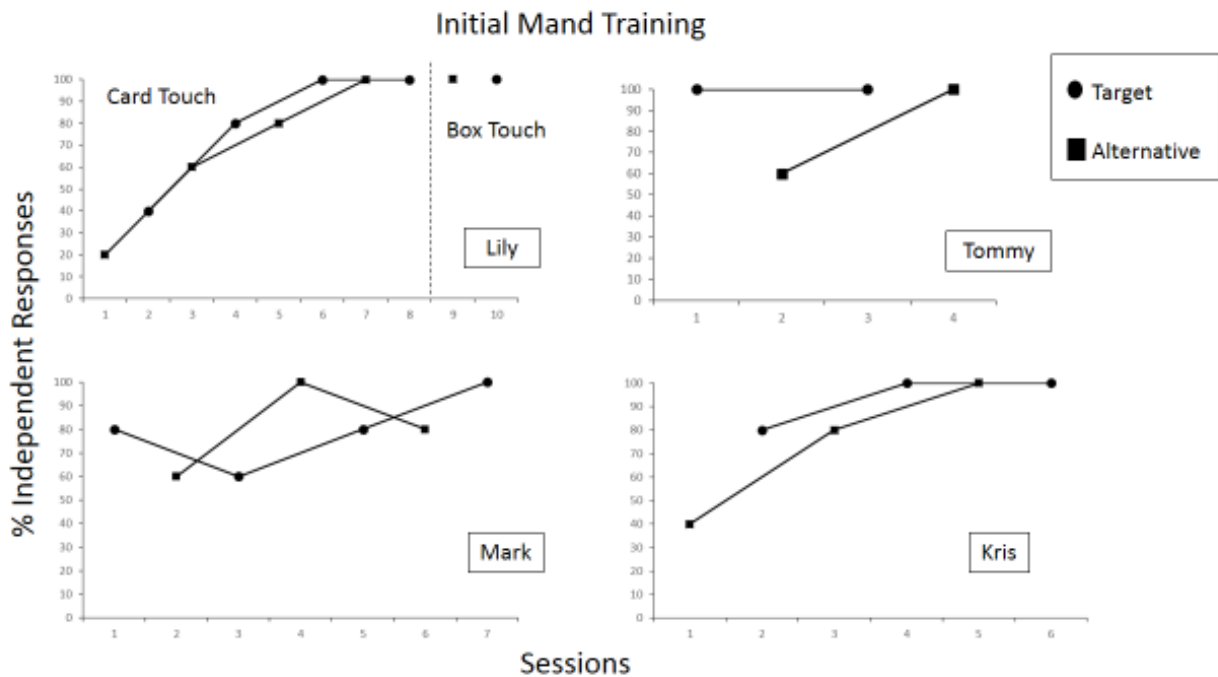


Figure 2. Results for initial training of both communication responses.

Initial Mand Training

Initial mand training was conducted for both the target and alternative response to establish each response within the participant's repertoire. Results are displayed in *Figure 2*. For Lily, we attempted using the microswitch press (not included on the above graph), however within the training period she began touching the microswitch during the reinforcement interval. Upon further inquiry, it was learned that Lily had a history of pressing buttons for automatic functions (such as to hear the clicking noise the button produced), and so a different modality was chosen (card touch). With card touch, Lily reached the criteria for mand training, however had difficulty in discriminating the cards to reach the terminal criteria for phase 2 and so the cards were placed on raised boxes and distinct photos were added to each colored card, which were more easily discriminated during phase 2. The above graph shows results for the initial

mand training of the card and then subsequent training of card touch on raised boxes. Mark, Tommy, and Kris all reached the mastery criteria quickly.

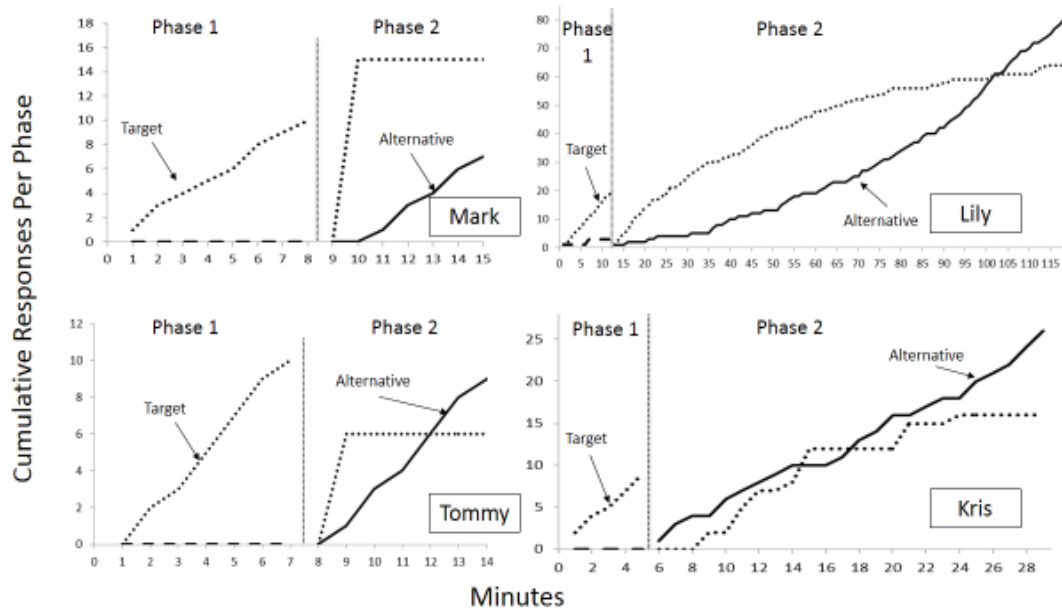


Figure 3. Cumulative responses for target and alternative responses across participants for phase 1 and phase 2 represented in 1-min bins.

Phase 1 and Phase 2

Results for phase 1 and phase 2 are displayed in *Figure 3* for all participants. In phase 1, all participants reached consistent responding on the target response quickly (all under 12 minutes). In phase 2, Mark and Tommy followed similar patterns of responding. They both showed initial high rates of responding on the target response within the first two minutes of the condition, and subsequently zero responses allocated to the target response. They then showed consistent responding on the alternative communication response, reaching the terminal criteria of five minutes relatively quickly.

Kris used both communication responses at similar rates initially, and then began to discriminate at 15 minutes. He did not reach the criteria of consistent responding on the alternative response (and no target responses) until 29 minutes into the protocol.

Lily initially responded more often using the target response. She required additional discrimination training which involved the use of prompts, change-over delays and brief removal of the communication cards following the target response to reach criteria for moving to the third phase of the experiment. In the above graph, only independent responses on the alternative response were displayed (i.e. prompted responses were not included in the cumulative count, as they were not considered responses that would be included in reaching the terminal criteria for phase 2). Because of the persistent history of the target response, we continued this condition until Lily had reached the terminal criteria multiple times to ensure stability by visual analysis.

Experimental Phase

Phase 3

For simplicity in interpretation, only the target response (i.e. the response that is considered “resurgence”) was shown. All participants followed usual extinction curves for the alternative response, showing more responding during the “No Items” condition compared to when low-preferred items were present.

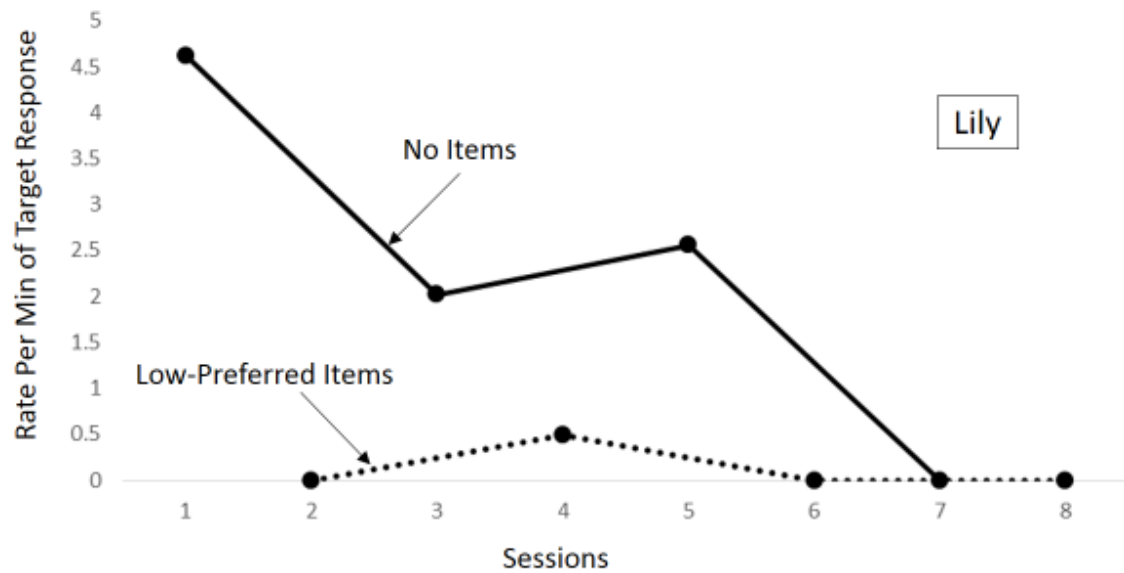


Figure 4. Rate per minute of target response across sessions during Phase 3 for Lily.

Phase 3 Results for Lily. Lily's phase three results showed differential resurgence across the two conditions. In the condition where no items were present, Lily consistently showed higher responding. When low-preferred items were available during the "test for resurgence" near-zero levels of responding on the target microswitch were observed.

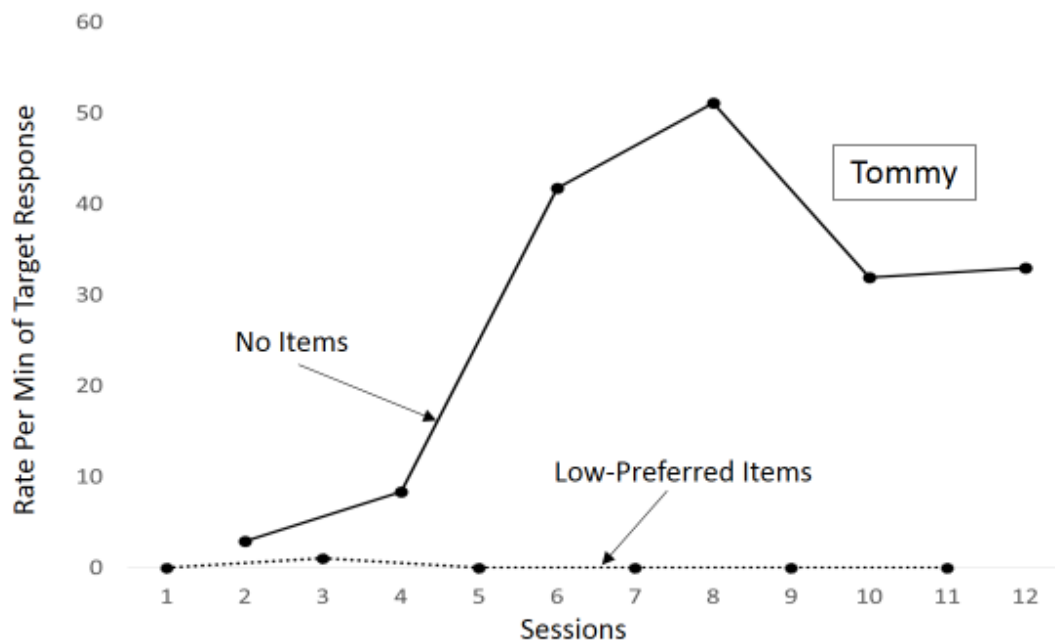


Figure 5. Rate per minute of target response across sessions during Phase 3 for Tommy.

Phase 3 Results for Tommy. Tommy's results (displayed in Figure 5) were similar to Lily's showing clear differentiation between the two conditions. Tommy's pattern differed slightly in that the differential resurgence was lower at first, and then rose rapidly, following a more traditional extinction burst pattern. Also, Tommy's rate of responding during the "No Items" condition was much higher than Lily's. Both had near-zero target responses when the low-preferred items were present during extinction conditions.

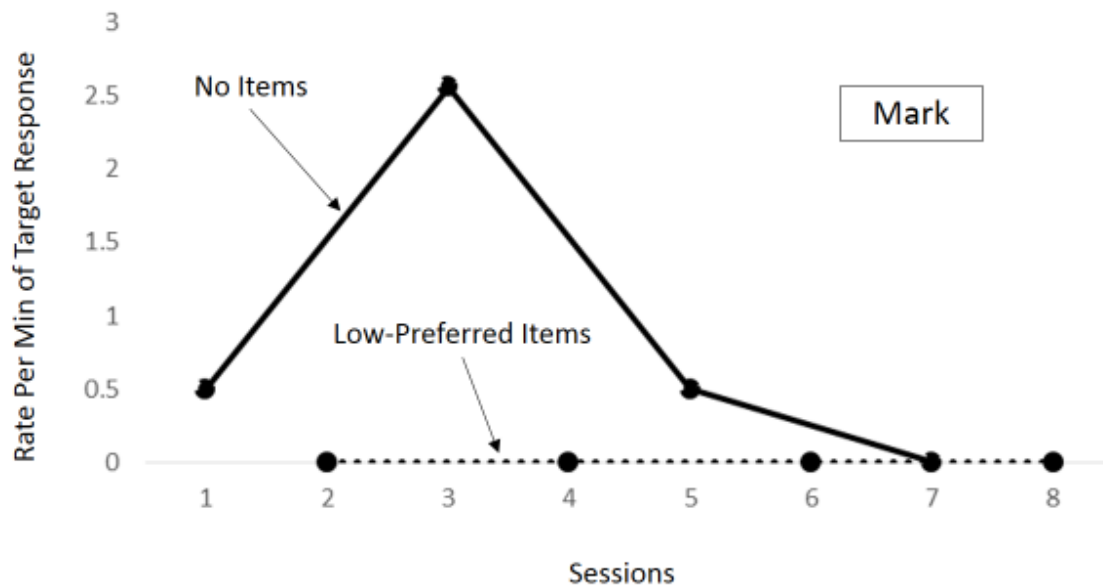


Figure 6. Rate per minute of target response across sessions during Phase 3 for Mark.

Phase 3 Results for Mark. Consistent with Lily and Tommy’s results, Mark also showed clear differentiation across the two conditions, with higher responding occurring in the condition with no items, and zero responding occurring when low-preferred items were present (See Figure 6). Mark’s pattern of responding across sessions began lower and increased, then subsequently decreased to zero in the “No Items” condition.

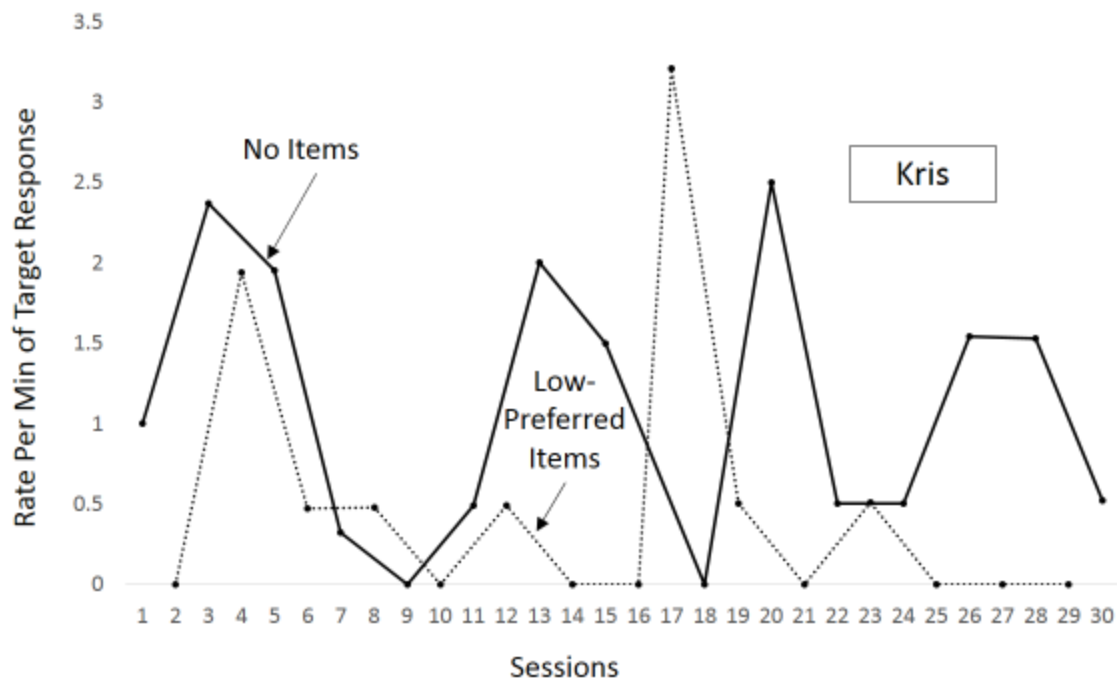


Figure 7. Rate per minute of target response across sessions during Phase 3 for Kris.

Phase 3 Results for Kris. Results for Kris during Phase 3 differ from the other participants' data. His responding was more variable and showed no consistent differentiation across the conditions. Though there was some differentiated responding beginning at session 24, we cannot draw any conclusions from this due to the previous overlap and high variability within the data. Given that we had run 30 sessions under extinction conditions, we made the decision to stop at 30 sessions.

Summary

In summary, three out of four participants showed higher rates of resurgence of the target communication response when no low-preferred items were available. One participant's results were inconclusive. Having low-preferred items available when requests for high-preferred items

will not be reinforced did reduce resurgence of responding to near-zero levels for three out of four participants.

CHAPTER 5: DISCUSSION

This chapter will discuss results of the current investigation, explain limitations of the current project, explore avenues of future research, and finally, offer a summary of conclusions.

Results

Access to low-preferred items mitigates resurgence

The current literature on resurgence shows that rate of reinforcement has a major impact on resurgence. More specifically, a number of studies have suggested that the higher the rate of reinforcement for an alternative response, the higher the resurgence of the target response when reinforcement was no longer provided for the alternative (e.g., Leitenberg, Rawson, & Mulick, 1975; Sweeney & Shahan, 2013). This presents a conundrum for application in terms of treatment of challenging behavior because it is often the treatment recommendation to increase the rate of reinforcement for the alternative appropriate behavior to “tip the scales” and make it more likely that the individual will communicate using appropriate means (as compared to challenging behavior; e.g. Kelley, Lerman & Van Camp, 2002). This recommendation, while making it more immediately likely that the appropriate request will occur, may also inadvertently make it more likely that challenging behavior will recur when the request cannot be reinforced. This is a daily problem for families of persons with disabilities with communication delays that have a history of challenging behavior. It is impossible to reinforce every request for a high-preferred item, for a variety of practical reasons. Sometimes it is not healthy to deliver a high-preferred item such as candy or soda. Many persons with autism enjoy electronic items as reinforcers. These items require power or sometimes internet access which may not be immediately available. Caregivers face the situation of having to deny access to high-preferred

items usually multiple times per day. The current study results suggest that maybe clinicians do not have to decrease the rate of reinforcement but rather the quality of the reinforcer. Perhaps caregivers that offer an environment rich in lower-preferred items can reduce the occurrence of resurgence when a high-preferred reinforcer is not available. The current investigation showed lower levels of communicative resurgence when persons were given access to low-preferred items, laying the groundwork for future studies that could investigate whether this might hold true for challenging behavior as well.

Experimental Design

One of the difficulties in translating research from animal studies to humans is one of experimental control. Often, the design elements that allow for tight experimental control in basic studies are not easily translated to applied situations. For example, when rats and pigeons are used as subjects, extra-experimental histories are controlled for (i.e. they do not have access to the responses when not under experimental conditions). History is much harder to control for when working with a population of persons with developmental disabilities, as withholding the ability to communicate is not possible. In addition, basic populations are more homogenous and animal participant numbers are often higher compared to that of applied studies, making the use of comparisons across groups experimentally feasible (e.g., Pyszczynski & Shahan, 2014; Quick, Pyszczynski, Colston & Shahan, 2011). When translating to a study that can be implemented with humans (and with vulnerable populations such as persons with developmental disabilities), finding a design that is feasible (both practically and ethically) and preserves experimental control is difficult. Volkert et al. (2009) used ABAB single subject design logic in their studies to demonstrate resurgence, where they repeated all three phases of resurgence multiple times. This logic functioned to demonstrate resurgence; however, it is not an option when making more

subtle experimental manipulations and comparisons within phases. It is difficult to run a full reversal with resurgence because the resurgence model requires two pre-phases. Running these phases in a full reversal design introduces the greater possibility for extraneous factors to influence the results, such as history and sequence effects. This makes comparison of phase 3 results (using the ABAB design logic) problematic. The current study used a multi-element design (with brief alternation across conditions) within phase 3. Of the reviewed applied phase 3 studies, only one used alternation between two conditions (i.e., Wacker et al., 2013), and the results were undifferentiated. In the current investigation, this design yielded clear results for most participants when investigating the impact of environmental modifications, and offered better control over sequence effects compared to running the entire paradigm multiple times. This design should be considered as an option going forward for applied researchers when comparing different phase 3 conditions.

Brief Phases and Session Length

In previous applied work, the session lengths were longer (sometimes 10 minutes per session). In the current study, phase 1 and 2 were relatively brief (while still meeting the criteria for resurgence). “Five minutes of consistent responding” established stability before moving to the next phase. This allowed for the phases to be run quickly (eliminating confounding variables such as reinforcement outside the experimental context and other history effects). In phase 3, sessions were two minutes (followed by a 30 s inter-trial-interval) and yielded clear differentiation rapidly for three out of four participants. The use of long sessions over multiple days, sometimes weeks (especially when exposing a clinical population to extinction conditions as is the case during phase 3) is not ideal. The briefer model proposed in this study reduced exposure to extinction conditions while still providing valid results. A briefer model could be

used more widely and would likely be more acceptable among practitioners and families of persons with developmental disabilities.

Limitations

Dependent Variable

Given that this was the first applied study to use this brief multi-element experimental design, one main object was to show differentiated results within a novel experimental model, and therefore the current study used equivalent topographies of two communication responses for target and alternative responses. Therefore, we cannot make statements about what might occur if the two dependent measures were distinct (as is the case with FCT, which seeks to replace challenging behavior with a functionally-equivalent but topographically distinct response.) In addition, the current study used communication responses that likely have a much simpler history of reinforcement compared to challenging behavior, and therefore no conclusions can be drawn on the impact of offering low-preferred items in phase 3 on the re-emergence of challenging behavior. This, of course, is an important applied question for future research.

Inconsistent Results Across Participants

Though the experimental control among the participants that showed differentiated results was high (the difference across the conditions was clear and repeated), there was one participant that did not show clear differentiation. We cannot know the reasons for this, but the differences across participants suggest that there might be other factors that contribute to resurgence and that the presence and absence of low-preferred reinforcers is only one aspect that contributes to resurgence.

Low-Preferred Items

The current investigation used preference assessment methods that produced rank order comparisons of preferred items. Individuals that have many high preferred items (that function as effective reinforcers), may show little difference between the quality of reinforcement among items identified in a preference assessment (as was done in the current investigation).

Alternatively, there might be participants that have very few functional reinforcers. In this case, there might be a much greater difference between the highest and lowest preferred item, in terms of efficacy of reinforcement. These two profiles could yield different results when using inequivalent reinforcers as some individuals might find the lower-preferred items nearly equivalent in terms of competing with high-preferred items, and thus show lower resurgence when given access to the low-preferred items. Conversely, individuals that have only one high-preferred reinforcer might have greater resurgence under the conditions where low-preferred items were available.

Brief Protocol and Definition of Extinction

While the brief protocol met the definition of resurgence and helped to control for some extraneous variables not controlled for in the previous “longer” resurgence paradigms (i.e. Volkert et al., 2009), there are potential confounds within the model that have yet to be investigated. For instance, for resurgence to occur, the previous response must reach some definition of extinction. The current brief model required that participants go at least five minutes without responding on the target response before initiating phase 3. This definition leads to future questions: if the extinction criteria were more stringent, would we see similar results?

In addition, the current model followed a 3-phase resurgence model that combined extinction of the first response with simultaneous reinforcement of the second response, as opposed to a four-phase resurgence model that separated out extinction (e.g. Bruzek et al, 2009;

Hoffman & Falcomata, 2014). It could be argued that the contingency between a response and a reinforcer was not completely broken if a similar response concurrently resulted in access to the reinforcer. This could be a criticism of all models of resurgence that used the 3-phase experimental protocol (e.g. Marsteller & St.Peter, 2012; Marsteller & St. Peter, 2014; Volkert et al., 2009; Wacker et al., 2013).

Mechanisms of Resurgence

The rationale for the current investigation used the logic behind previous resurgence research that FT schedules during phase 3 mitigate resurgence (Lieving & Lattal, 2003; Marsteller & St. Peter, 2014). If we conceive that the low-preferred items are available on a very dense, albeit continuous, schedule (during phase 3), then it would stand to reason that the presence of these items might decrease resurgence. However, the current study did not isolate the specific behavioral mechanisms responsible for resurgence (as many basic studies do). As phase 3 sessions continued, the low-preferred items could also serve as a signal that the high-preferred items are not available, and gain stimulus control properties that decrease the likelihood of resurgence. These variables were not isolated in the current experiment. Collaboration with basic researchers who can more easily isolate these mechanisms with more complex controls is important.

Future Research

Basic research

One element of applied research that is difficult to translate into basic inquiry is the manipulation of preference. Preference assessments for persons with disabilities have become an essential part of developing effective interventions for persons with disabilities. The

manipulation of preference and its effects on treatments and learning are well-documented in the applied literature (Cannella, O'Reilly, & Lancioni, 2005; Tullis et al., 2011). This concept of preference is difficult to translate because animals often have more limited repertoires of reinforcers, however it might be beneficial for basic researchers to develop an analog (perhaps reinforcer magnitude) that can be manipulated to investigate the effects of “preference” on resurgence. Another approach that might be helpful would be to study the effect of the availability of non-equivalent reinforcers (food versus drug) on resurgence during phase 3. If a preference can be established for one of the two, then a study that explores a similar basic question can be devised.

The basic researchers can continue to work to answer questions that are not amenable to be answered in applied settings, such as uncovering the underlying mechanisms behind the results of the current study (e.g. Podlesnik & Kelley, 2014). Do the low-preferred items represent a signal that high-preferred items are not available or do they function to decrease resurgence by providing continuous reinforcement? Further investigations that tease out the role of stimulus control and reinforcer control mechanisms of resurgence can build a platform for understanding better why applied interventions work, and give applied researchers ideas of how to improve the interventions, basing future permutations on the foundations of basic behavioral findings.

Translational Research

Because preference is a difficult concept to translate to animals, it might be wise to investigate preference or the use of non-equivalent reinforcers and its effect on resurgence within translational work, such as with humans without disabilities. Human operant labs provide a good environment to do more controlled studies that integrate more uniquely human qualities – such

as differential preference. The current study's brief design provides a good template for translational studies investigating resurgence in non-clinical populations.

Applied Research

As mentioned above, the most obvious extension of the current investigation would be to replicate the current study with challenging behavior and appropriate communication, as the target and alternative responses, respectively. This investigation would have wide applicability considering the broad use of FCT as the treatment of choice for challenging behavior within the population of persons with disabilities.

Further, applied researchers could utilize this study's design to study other phase 3 factors that might affect resurgence, such as whether or not the high-preferred items remain visually present, or whether the use of signals with stimulus control properties might reduce resurgence.

Conclusion

The current investigation fits within the resurgence literature, building on previous knowledge of resurgence while offering fodder for future studies in the basic and applied research realm. Continued collaboration and communication between basic and applied researchers will further help to move questions and answers "downstream" in an efficient way, and result in more durable interventions for lasting change in the treatment of challenging behavior and the building of appropriate communicative behaviors in persons with disabilities.

APPENDIX

Table 1. Resurgence Phases 1-3 of the Reviewed Studies

Study	Responses	Phase 1	Phase 2	Phase 3	
<u>Applied</u>				<u>Part A</u>	<u>Part B</u>
Marsteller & St.Peter (2012), Experiment 2	Challenging Behavior Mands	FR 1 EXT	EXT FR 1	EXT RR 1.4	EXT EXT
Marsteller & St. Peter (2014)	Challenging Behavior Mands	FR 1 EXT	EXT FR 1	FT 1s/FT 2s	EXT EXT
Volkert et al. (2009), Experiment 2	Challenging Behavior Mands	FR 1 --	EXT FR 1	EXT FR 12	EXT EXT
				Alternated contexts: MS vs. no MS	
Wacker et al. (2013)	Challenging Behavior Mands	FR 1 EXT	EXT FR 1	EXT EXT	
<u>Translational</u>					
Marsteller & St.Peter (2012), Experiment 1	Mouse Click Black Mouse Click Red	FR 1 EXT	EXT FR 1	EXT RR 1.4	EXT EXT
<u>Basic</u>					
Jarmolowicz & Lattal (2014)	Target Key Peck Alternative Key Peck	VI 30s EXT	EXT VI 30s	EXT VI 30s FT xs*	
Lieving & Lattal (2003), Experiment 3	Key peck Treadle Press	VI 30s --	EXT VI 30s	EXT VT 30s	EXT EXT
Lieving & Lattal (2003), Experiment 4	Key peck Treadle Press	VI 30s --	EXT VI 30s	EXT VI 360s	EXT EXT
Podlesnick & Kelley (2014)	<u>Target Key Peck</u> Typical Resurgence Mod Resurgence Renewal	VI 60s (lit) VI 60s (lit) VI 60s (lit)	EXT (lit) EXT (lit) EXT (dark)	EXT (lit) EXT (lit) EXT (lit)	
	<u>Alternative Key Peck</u> Typical Resurgence Mod Resurgence Renewal	-- -- --	VI 60s (lit) VI 60s (lit) EXT (lit)	EXT (lit) EXT (dark) EXT (dark)	
Pysczynski & Shahan (2014)	Lever Press Nose Poke	VI 45s --	EXT VI 10s	Group 1 vs Group 2: D₂ Agonist vs. A₂ Agonist injection	EXT EXT
Quick, Pysczynski, Colston & Shahan (2011)	Lever Press (Cocaine) Nose Poke (Pellet)	VR 20 --	EXT VR 20	Group 1 vs Group 2: D₂ Agonist vs. Saline Injection	EXT EXT

Notes. EXT = Extinction; FR = Fixed Ratio; FT = Fixed Time; MS = Microswitch; RR = Random Ratio; VI = Variable Interval; VR = Variable Ratio; VT = Variable Time; **Bolded** = Manipulated Variable; * for the progressive delay schedule, x = .5, 1, 5, 10, 20...

Table 2. Experimental Question and Results of the Reviewed Resurgence Studies

Study	Experimental Question	Results
<u><i>Applied</i></u>		
Marsteller & St.Peter (2012), Experiment 2	Will reducing the rate of reinforcement for the appropriate mand response following phase 2 produce resurgence of challenging behavior in a child with autism? How does this rate compare to resurgence under extinction conditions?	Greater resurgence occurred during both extinction phases compared to the omission-errors phase, with the greatest resurgence occurring during the first exposure to extinction conditions.
Marsteller & St. Peter (2014)	Does a FT schedule (yoked to previous DRA reinforcement rates) mitigate resurgence of challenging behavior and maintain appropriate requesting in children with disabilities?	Response-independent reinforcer delivery (FT schedule) following DRA prevented resurgence of previously reinforced challenging behavior and maintained appropriate manding with humans in a treatment context. Rates of requests during FT condition were more variable than during DRA condition.
Volkert et al. (2009), Experiment 2	If appropriate communication is placed on thin schedules of reinforcement (FR 12), will resurgence of challenging behavior occur?	Resurgence of challenging behavior was demonstrated twice for all 3 participants during very thin, "extinction-like" conditions.
Wacker et al. (2013)	Does the presence of an unprogrammed microswitch during phase 3 (a stimuli associated with previous reinforcement) affect the level of resurgence of challenging behavior under extinction conditions?	Resurgence of challenging behavior occurred under extinction conditions, and was not affected by the presence of a stimuli (microswitch) previously associated with reinforcement.
<u><i>Translational</i></u>		
Marsteller & St.Peter (2012), Experiment 1	Will reducing the rate of reinforcement for the response 2 following phase 2 produce resurgence of response 1 in humans? How does this rate compare to resurgence under extinction conditions?	Higher mean rates of responses on the black circle were observed when reinforcement was reduced, though at much lower rates as compared to the extinction sessions.
<u><i>Basic</i></u>		
Jarmolowicz & Lattal (2014)	Does implementing delays to reinforcement during the "test for resurgence" result in resurgence of the first-trained response in pigeons?	Resurgence of left key pecking observed for 3 out of 4 pigeons during the progressive delay session.
Lieving & Lattal (2003), Experiment 3	Would changing to a time-based schedule of reinforcement for treadle pressing cause resurgence of key pecking?	No resurgence when treadle press was switched to VT schedule.
Lieving & Lattal (2003), Experiment 4	Does a thin schedule of reinforcement for treadle pressing (second response) cause resurgence of key pecking (first response)?	"Resurgence" observed on thin schedule for 2 out of 3 pigeons, but of lower magnitude compared to extinction-only condition

Podlesnick & Kelley (2014)	Is resurgence a phenomena that is produced by adding and removing reinforcement (Typical resurgence) or adding and removing discriminative stimuli (Modified resurgence) associated with reinforcement?	Adding and removing alternative reinforcement has greater impact on resurgence than adding and removing the alternative stimulus, suggesting that resurgence is more influenced by reinforcer control than stimulus control.
Pyszczyński & Shahan (2014)	How do different doses of raclopride and clonidine prior to phase 3 affect resurgence of target response and alternative responses?	Raclopride group: Reduced target and alternative responding during test for resurgence in phase 3; Clonidine group: Reduced the target response, but had little effect on the alternative response.
Quick, Pyszczyński, Colston & Shahan (2011)	Does resurgence of cocaine-seeking occur when loss of non-drug reinforcement occurs? Are there differences in resurgence when a dopamine agonist is injected prior to the resurgence test?	Loss of non-drug reinforcement in phase 3 produced resurgence of cocaine-seeking behavior in the control group. No resurgence occurred for the group that was injected prior to phase 3 with a dopamine agonist.

Notes. DRA = Differential Reinforcement of Alternative Behavior; FR = Fixed Ratio; FT = Fixed Time; VT = Variable Time

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